

UNITED STATES PATENT APPLICATION

OF: Brian Barber and John Young

FOR: APPARATUS AND METHOD FOR APPLYING  
ADHESIVE TO TUBING

**This application claims priority of U.S. Provisional Patent Application No. 60/324,813 filed September 17, 2001.**

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The invention relates to medical tubing, and more particularly relates to an apparatus and method for applying adhesive to a section of the outer surface of a length of tubing.

2. Background of the Invention

[0002] Many medical procedures employ a length of flexible plastic tubing for delivering fluid to a patient or for withdrawing bodily fluids from a patient. Opposed ends of the tubing typically are placed permanently in communication with plastic fittings. The typical plastic fitting includes opposed proximal and distal ends and a passage extending between the ends. Portions of the passage adjacent the proximal end of the fitting are dimensioned to receive an end of the flexible plastic tubing. The distal end of the plastic fitting may be configured for placement directly in communication with a patient or for placement in communication with another fitting.

[0003] The connection between the end of the plastic tubing and the proximal end of the plastic fitting must prevent separation of the tubing from the fitting in response to pulling forces and also must achieve a fluid-tight hermetic seal. An adhesive typically has been employed for this

one longitudinal side of the plastic tubing adjacent the end of the tubing. The end of the plastic tubing then is telescoped into the plastic fitting. The telescoping movement of the tubing is intended to urge the drop of adhesive completely into the annular space between the tubing and the fitting. This prior art procedure tends to cause some of the adhesive to be pushed into a bead on the tubing and externally of the proximal end of the plastic fitting. A sufficient accumulation of adhesive adjacent the proximal end of the fitting can affect the ability of external latches or shields on the fitting to perform properly. Additionally, it is difficult to assure that the adhesive has wicked properly into all areas between the plastic tubing and the fitting. Accordingly, it is difficult to ensure that a good hermetic seal has been achieved. A uniform distribution of the adhesive is difficult to achieve when the adhesive has a high viscosity. Hence, a low viscosity highly flowable adhesive typically is used for these purposes. This limits the selection of adhesives.

[0004] There also are disclosed attempts to secure plastic tubing to a fitting by first assembling the tubing to the fitting and then inserting adhesive into the annular space between the tubing and the fitting. The adhesive has been inserted, for example, with a small gauge needle and a low viscosity adhesive. This prior art approach again limits the types of adhesives that can be employed. Furthermore, this design is complicated and it is difficult to ensure that adhesive will flow uniformly into the annular space between a plastic tubing and the fitting.

### 3. Summary of the Invention

[0005] The subject invention is directed to an apparatus and method for applying a thin coat of adhesive uniformly to an outer circumferential surface region of a section of plastic tubing adjacent an end of the tubing. The apparatus comprises a pair of grippers that are selectively movable toward and away from one another. Each gripper may be formed from a metallic plate material with opposite front and rear faces and a tube-mating face extending between the front and rear faces. The front and rear faces of each gripper are spaced apart a thickness that is equal to or greater than the length of the tubing to which the adhesive is to be applied.

[0006] The tube-mating face of each gripper includes a concave adhesive transfer area located centrally between and substantially transverse to the front and rear faces. The concave shape of the adhesive transfer area in each gripper conforms to the external shape of the tubing and forms a common longitudinal axis with the grippers. Most tubing is substantially cylindrical, and hence the tube transfer areas define a concave semi-cylindrical surfaces. The dimensions of the adhesive transfer areas of the grippers are selected to enable the adhesive transfer areas to nest completely around the tubing without occluding the tubing.

[0007] The tube-mating face of each gripper further is characterized by front and rear counterbores extending into the respective front and rear faces of the gripper and symmetrically disposed around opposite ends of the adhesive transfer area. The counterbores, however, define a larger cross-sectional area than the adhesive transfer area.

[0008] The tube-mating face of each gripper further is characterized by a vacuum channel spaced from the adhesive transfer area and extending between the front and rear counterbores. The channels in the grippers are disposed to substantially register with one another when the grippers move toward one another.

[0009] Each gripper further includes an adhesive dispensing passage for delivery of adhesive to the adhesive transfer area of the gripper.

[0010] At least one gripper further includes a vacuum passage extending into communication with the vacuum channel and configured for communication with a vacuum source. Thus, the vacuum passage enables a low pressure to be applied to the channel and to the counterbores with which the vacuum channel communicates.

[0011] The apparatus is employed by delivering a controlled amount of adhesive through the respective adhesive dispensing passages and into the adhesive transfer areas. The flow of adhesive into the adhesive transfer areas may commence before the tubing is positioned between the grippers. The end of the tubing then is disposed between the grippers, and the grippers are

moved to engage around opposite sides of the tubing. Thus, the tubing is engaged in the adhesive transfer areas, but without a tight gripping that could occlude the tubing. The adhesive preferably has already commenced flowing into the adhesive transfer areas when the grippers are closed around the tubing so that adhesive in the adhesive transfer areas is urged continuously and circumferentially around the section of the tubing to which the adhesive is to be applied. A vacuum is applied at the vacuum passage typically as the grippers are being closed around the tubing. The vacuum draws excess adhesive into the counterbores. The adhesive then flows from the counterbores through the channel and through the vacuum passage for collection and/or recirculation. The vacuum contributes to a uniform thin coating of adhesive around the outer circumferential surface of the tubing and further contributes to removal of excess adhesive from areas where an adhesive build-up could affect performance of the medical device to which the tubing is connected. Additionally, the adhesive removal steps may be carried out simultaneously with the adhesive application steps, and as a result additional cleaning steps are not required for removing excess adhesive.

[0012] There is a definite need in the art of adhesive application for improvements which can overcome problems which arise with prior art apparatus. The present invention is directed to overcoming these problems and fulfilling this need.

#### 4. Brief Description of the Drawings

[0013] FIG. 1 is a schematic view of an adhesive applicator apparatus of the subject invention in a load position that permits loading of a section of tubing into the apparatus.

[0014] FIG. 2 is a perspective view of the grippers of the apparatus shown in FIG. 1.

[0015] FIG. 3 is a front elevational view, partly in section, of the first gripper.

[0016] FIG. 4 is an elevational view of the tubing mating face of the first gripper.

[0017] FIG. 5 is a front elevational view of the second gripper of the apparatus.

[0018] FIG. 6 is an elevational view of the mating face of the second gripper.

[0019] FIG. 7 is a perspective view of the first gripper with a section of tubing loaded therein.

[0020] FIG. 8 is a schematic view similar to FIG. 1, but showing the grippers engaged around the section of tubing.

[0021] FIG. 9 is an enlarged view of portions of the grippers engaged with the tubing.

[0022] FIG. 10 is an exploded cross-sectional view showing the tubing with the adhesive applied thereto and in proximity to a plastic fitting.

[0023] FIG. 11 is a cross-sectional view of the tubing fully mounted in the fitting.

## 5. Detailed Description of the Invention

[0024] An apparatus for applying adhesive to an outer circumferential surface of a short section of plastic tubing is identified generally by the numeral 10 in FIG. 1. Apparatus 10 includes first and second grippers 12 and 14 respectively. Grippers 12 and 14 are mounted to a pneumatic actuator cylinder assembly 16 which is operative for moving grippers 12 and 14 from a load position shown in FIG. 1 to a dispense position described and illustrated below. Grippers 12 and

14 are spaced from one another in the load position shown in FIG. 1, but move toward one another in the dispense position.

[0025] Apparatus 10 further includes an adhesive supply 18 that communicates with first and second valves 22 and 24 respectively. First and second valves 22 and 24 communicate respectively with first and second grippers 12 and 14 and are operative for selectively directing adhesive from adhesive supply 18 to first and second grippers 12 and 14.

[0026] Apparatus 10 further includes a vacuum source 26 that communicates with first gripper 12.

[0027] First gripper 12 is machined from a stainless steel material and includes opposite substantially parallel planar front and rear faces 28 and 30. Front and rear faces 28 and 30 are spaced from one another by a distance "a", as shown in FIG. 2, that equals or slightly exceeds the length of tubing to which adhesive is to be applied. First gripper 12 is an elongate structure with an upper mounting end 32 and a lower tube engaging end 34. Mounting end 32 is characterized by a mounting aperture 36 for mounting first gripper 12 to pneumatic actuating cylinder assembly 16. First gripper 12 also is characterized by an adhesive supply face 38 and an opposed tube mating face 40 each of which extends between the front and rear faces 28 and 30.

[0028] Tube mating face 40 is characterized by a generally semi-cylindrical concave adhesive transfer area 42 generated about an axis aligned substantially perpendicular to front and rear faces 28 and 30 of first gripper 12. Adhesive transfer area 42 defines a diameter equal to or slightly greater than the outside diameter of the length of tubing to which adhesive will be applied. An adhesive supply passage 44 extends through first gripper 12 from adhesive supply face 38 to adhesive transfer area 42, as shown in FIG. 3. More particularly, adhesive supply passage 44 intersects adhesive transfer area 42 at a location 46 disposed centrally between front and rear faces 28 and 30 and at an above-center position on a side of the axis of adhesive transfer area 42 further from lower end 34 of first gripper 12, as shown in FIGS. 3 and 4.

[0029] Front and rear counterbores 48 and 50 extend into front and rear faces 28 and 30 of first gripper 12. Front and rear counterbores 48 and 50 are cross-sectionally larger than adhesive transfer area 42 and are substantially symmetrically disposed around opposite ends of adhesive transfer area 42.

[0030] A generally U-shaped vacuum channel 52 is formed into tube mating face 40 of first gripper 12 at a location between lower end 34 of first gripper 12 and adhesive transfer area 42. More particularly, vacuum channel 52 has a front end 54 communicating with front counterbore 48 and a rear end 56 communicating with rear counterbore 50. A vacuum passage 57 extends through first gripper 12 from adhesive supply face 38 to a location in vacuum channel 52 approximately centrally between front and rear ends 54 and 56 of vacuum channel 52.

[0031] Second gripper 14 is structurally similar to first gripper 12. More particularly, second gripper 14 also is machined from a stainless steel material and has substantially parallel planar front and rear faces 58 and 60. Front and rear faces 58 and 60 are spaced from one another by a distance "a" substantially equal to the thickness of first gripper 12. Second gripper 14 further includes an upper mounting end 62 and a lower tube engaging end 64 substantially as with first gripper 12. A mounting aperture 66 extends through second gripper 14 to mount second gripper 14 securely on pneumatic actuating cylinder 16. Second gripper 14 further includes an adhesive supply face 68 and a tube mating face 70. A concave semi-cylindrical adhesive transfer area 72 is formed in tube mating face 70 at a location to register with adhesive transfer area 42 of first gripper 12 when grippers 12 and 14 are moved from the load position shown in FIG. 1 to the dispense position around a section of tubing. Second gripper 14 further includes an adhesive supply passage 74 that extends from adhesive supply face 68 to adhesive transfer area 72. The intersection of adhesive supply passage 44 with adhesive transfer area 42 is at an above center position as shown in FIG. 6 and as described with respect to first gripper 12.

[0032] Front and rear counterbores 78 and 80 extend into front and rear faces 68 and 70 of second gripper 14 at locations symmetrically surrounding opposite ends of adhesive transfer area 72. A U-shaped vacuum channel 82 is formed in tube mating face 70 at locations spaced from

adhesive transfer area 72. Vacuum channel 82 is disposed to register with vacuum channel 52 when first and second grippers 12 and 14 are moved into the dispense position described further below. In the illustrated embodiment, second gripper 14 is not provided with a vacuum passage comparable to vacuum passage 57 formed in first gripper 12.

[0033] Apparatus 10 is used with a length of PVC tubing 90 as shown in FIG. 7. Tubing 90 has an end 92 and an outer circumferential surface 94 extending entirely along the length of tubing 90. Portions of outer circumferential surface 94 in proximity to end 92 are to be hermetically sealed and fixedly secured in a plastic fitting intended for medical applications. Adhesive is applied to outer circumferential surface 94 of tubing 90 adjacent end 92 by loading end 92 of tubing 90 into the space between adhesive transfer areas 42 and 72 of first and second grippers 12 and 14. A flow of adhesive material then is initiated by actuating first and second valves 22 and 24 respectively to permit adhesive to flow from first and second valves 22 and 24 into adhesive passages 44 and 74, and hence into adhesive transfer areas 42 and 72. First and second grippers 12 and 14 are moved under the action of pneumatic actuating cylinder assembly 16 toward one another and into surrounding relationship with tubing 90, as shown in FIGS. 8 and 9. At this point, adhesive 96 has entered upper regions adhesive transfer areas 42 and 72 and flows slightly downward due to gravitational forces. Movement of grippers into the dispense position of FIGS. 8 and 9 urges adhesive 96 against outer circumferential surface regions 94 of tubing 90 adjacent end 92. The relative cross-sectional dimensions of adhesive transfer areas 42 and 72 help to achieve a smooth uniform distribution of adhesive 96 circumferentially around outer surface 94 of tubing 90 adjacent end 92.

[0034] Substantially simultaneously with movement of grippers 12 and 14 into the dispense position of FIGS. 8 and 9, vacuum source 26 is activated to create a low pressure that communicates with vacuum passage 57 and registered vacuum channels 52 and 82. Channels 52 and 82 communicate with registered front counterbores 48 and 78 and registered rear counterbores 50 and 80. Hence, adhesive 96 is drawn toward the counterbores by the low pressure to ensure the continuous circumferential coating of adhesive around outer surface 94 of tubing 92. Excess adhesive 96 then is drawn away from counterbores 48, 50, 78 and 80, through



registered vacuum channels 52 and 82 and through vacuum passage 57 in first gripper 12. Actuating cylinder assembly 16 then is actuated again to move grippers 12 and 14 from the FIG. 8 condition into the FIG. 1 position. Tubing 90 is removed from apparatus 10 and has a thin uniform coating of adhesive 96 as shown in FIG. 10. End 92 of tubing 90 may be inserted into fitting 98 as shown in FIG. 11, and may be subjected to UV radiation for curing. As illustrated schematically in FIG. 11, substantially no excess adhesive exists either at the opening of fitting 98 or at end 92 of tubing 90. Hence, fluid flow through tubing 90 is not impeded and latches or other safety structures on fitting 98 are not affected by excess adhesive 96.